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The Biology and Morphology of the Immature Stages of *Asterocampa idyja argus* (Bates) (Lepidoptera: Nymphalidae)

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Abstract. The immature stages of *Asterocampa idyja argus* (Bates) (Lepidoptera, Nymphalidae, Apaturinae) are described for the first time from specimens collected in southern Mexico. An investigation of external characters of eggs, late instar larvae and pupae was carried out with the aid of scanning electron microscopy. A nomenclature for larval head capsule scoli is proposed. A new structure, the crampets, found on the prolegs of caterpillars, is described. *Celtis caudata* Planch. was found to be the larval host plant in southern Mexico. This is the first recorded host for this hackberry butterfly.

Introduction

Species of *Asterocampa* Röber (Lepidoptera, Nymphalidae, Apaturinae), known as hackberry butterflies, occur in North and Central America and the Greater Antilles. The developmental stages of 2 widely distributed species, *A. clyton* (Boisduval & Le Conte) and *A. celtis* (B. & L.), are known from populations in the eastern United States (Riley, 1874; Edwards, 1880, 1881, 1884, 1897; Scudder, 1889). Other populations of these two species from the southwestern United States, and the remaining two species of *Asterocampa* have received little attention (Comstock, 1953, 1961; Gundlach, 1881). Comstock described the mature larva and pupa of *A. leilia* (Edwards) from Arizona in 1953. However, the early instar larvae which he described as *A. leilia* actually belong to another species, *A. clyton texana* (Skinner) form "subpallida." The mature larva and pupa of *A. idyja idyja* (Geyer) from Cuba were described by Gundlach (1881), but were not illustrated.

Eggs, third, fourth and fifth instar larvae, and pupae of the Central American *A. idyja argus* (Bates) are described here for the first time from specimens collected in the states of Oaxaca and Guerrero, Mexico. Unhatched egg masses and early instar larvae were not observed or obtained through rearing.

Materials and Methods

MATERIAL COLLECTION AND REARING. The immature stages of

Asterocampa idyja argus were collected from their host trees during July of 1980 and 1981 in 2 localities in southern Mexico. A (partial?) clutch of third and pharate fourth instar larvae from near Cacuamilpa in northern Guerrero were the earliest instar larvae found. Hatched egg masses, fourth and fifth instar larvae, larval skins and head capsules, pupae and pupal cases were found in abundance near Totolapan in southeastern Oaxaca. Branchlets with evidence of larval feeding damage, leaves with silken larval resting pads or frass, and a few adult butterflies were also collected.

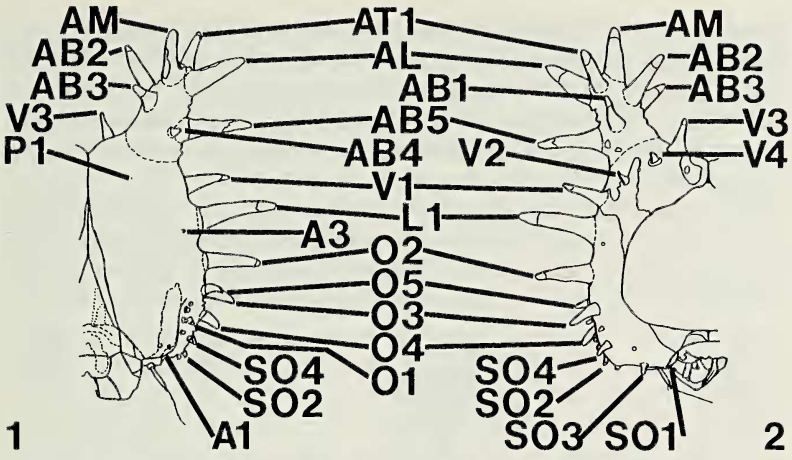
The majority of larvae and pupae were preserved immediately and the remainder reared for determination.

MATERIAL PREPARATION. Egg shells and larval head capsules were air-dried and mounted on scanning electron microscope stubs with a quick-drying plastic. After coating the eggs with gold/palladium, they were viewed with a JEOL, JSM-25SII scanning electron microscope. Some larval heads were removed, soaked in KOH at room temperature for a few hours, stained in mercurochrome, and cleaned with a brush. The parts were then cleared in clove oil, hardened in xylene and mounted on microscope slides in balsam. One third and one fifth instar larva were critical-point dried and prepared for scanning electron microscopy.

NOMENCLATURE. Color descriptions were made from direct observation of live and preserved specimens and from color photographic slide transparencies taken of live material. Color names are those used in ordinary description followed in parentheses (where different) by names in the National Bureau of Standards' color dictionary (Kelly and Judd, 1976).

Nomenclature used to describe the morphology of immature stages is taken from a variety of sources, including Kuznetsov (1967) and Razowski (1976). To describe head capsule structure and coloration in detail it was necessary to construct a new nomenclature of head horns, as no previous nomenclature existed. An attempt was made to use a terminology consistent with head capsule setal homology (Hinton, 1946), so as to permit phylogenetic analysis among caterpillars with homologous head capsule structure.

The paired, branching scoli (Figs. 1, 2) found at the dorsolateral corners of the head capsule are each termed "A," for "antler," as these are not homologous with any named primary seta. The branches of the antlers are named according to their location. Of the terminal forked pair of scoli the more lateral is designated "AL" and the more mesal "AM." Other scoli associated with the terminal pair are designted by the prefix "AT," and numbered from the posteriormost towards the meson around the antler (clockwise as viewed dorsally for the right antler). There is one (AT1) in *Asterocampa*. Scoli more basad on the trunk of the antler are



Figs. 1 & 2. Head of mature larva with major scoli labelled: **1,** front view; **2,** back view.

designated by the prefix "AB." They are numbered in a similar manner, from the posteriormost towards the meson around the antler. There are 5 in *Asterocampa* (AB1, AB2, AB3, AB4, AB5).

Some of the unbranched scoli of the cranium are homologous with primary setae named by Hinton (1946) (as determined in developmental sequences in other *Asterocampa* species). The prominent pair of scoli on the vertex is the dorsalmost pair of vertical setae (V3). A similar pair of scoli on the occiput, just ventral to the antlers in frontal view, is the ventralmost pair of vertical setae (V1). The top pair of long lateral scoli are the lateral setae (L1). The next lower pair of lateral scoli are the second ocular setae (O2). The next lower pair of lateral scoli on the occiput are the third ocular setae (O3). The first ocular setae (O1) appear as scoli just lateral to the arc-forming simple eyes. Subocular setae SO2 and SO3 appear as scoli behind and below the eyes as figured. On the face of the larva only the first and third anterior setae (A1, A3) appear as scoli and these are very small. The first pair of parietal setae (P1) are found at the anterior bases of the antlers.

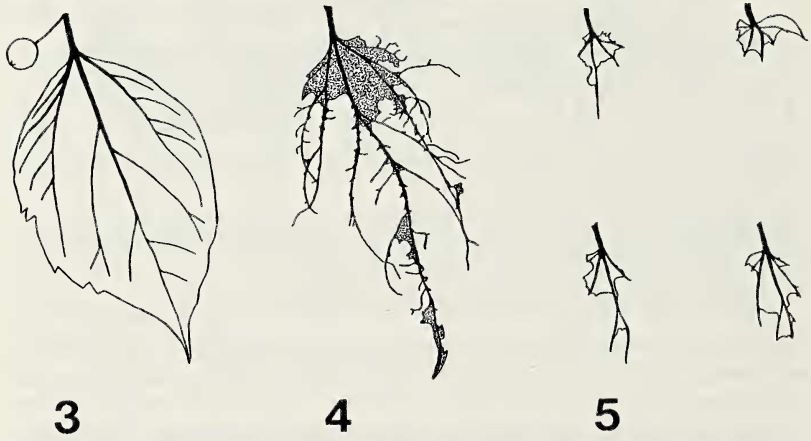
Several scoli of the vertex and subocular regions have no corresponding primary setae. These secondary scoli are designated by the prefix of their cranial areas and numbered in order of their appearance during larval development (numbers beginning beyond those given to primary setae; see Figs. 1, 2).

Observations on the Biology of the Immature Stages of *A. idyja argus*

HOSTS. The host plant species from which the immature stages of *Asterocampa idyja argus* were collected is *Celtis caudata* Planch. The

determination of this plant was made using the key to species of hackberry in Mexico by Standley (1922). The tree occurs only in the central part of the range of the butterfly. *A. idyja argus* is found from northwestern Mexico to Nicaragua, with an extension into northeastern Mexico (corresponding well with the Mexican Biotic Province, as illustrated in Durden, 1974).

Immature stages of *A. idyja argus* were located subsequent to finding larval feeding damage. The characteristic feeding damage on trees is the best indication of the presence of larvae. Typical damage is illustrated by the figures of pressed leaves collected in Oaxaca (Figs. 3-5).



Figs. 3-5. Leaves of *Celtis caudata* **3,** undamaged leaf with fruit, showing major veins; **4,** leaf fed upon by early instar larvae; **5,** leaf remains after feeding by late instar larvae.

EGGS. Two hatched egg masses were observed on terminal branchlets which showed larval feeding damage in the lateral canopy of one host tree. One of these was accessible and was collected. This egg mass is composed of (the remains of) 5 layers of closely packed egg shells (hexagonally close-packed). The outermost eggs remained intact because they were mostly parasitized by scelionid wasps (*Telenomus* sp.), and were not removed by emerged larvae. Eggs inside the mass are absent probably as a result of being dislodged and eaten by emerging larvae. As calculated from the stacking design there were 103 eggs in the bottom layer, and maxima of 85 in the second, 68 in the third, 52 in the fourth and 38 in the fifth and top layer. As a conservative estimate, the egg mass probably contained in excess of 300 eggs when deposited.

LARVAE. More than 200 third and pharate fourth instar larvae were found on a single leaf and adjoining stem on the host plant in Guerrero. The larvae were massed for molting near the tip of an exposed, hanging branch which exhibited extensive feeding damage.

Fourth, pharate fifth, and fifth instar larvae were found mostly inside the canopy of the host tree where many mature larvae were feeding. Larvae resting on the undersides of leaves assumed zigzag positions (body bent laterally twice), similar to illustrated larvae of *Timelaea maculata formosana* Fruhstorfer (Kubo and Muroya, 1967), another apaturine nymphalid. When not feeding, caterpillars tucked their head under, placing faces against the leaf, antlers to the front. Some mature larvae were found travelling along branches between leaf clusters, a few of them probably searching for pupation sites. Larvae swung their heads to the side and regurgitated food when handled.

PUPAE. Pupae and pupal cases were found on the same tree as mature larvae, on the undersides of leaves on branchlets very close to the main trunk and in the darkest shade within the canopy. Each pupa rested head downward with its longitudinal axis parallel to the leaf blade and its caudal end towards the petiole. The pupal stage lasted 7-8 days.

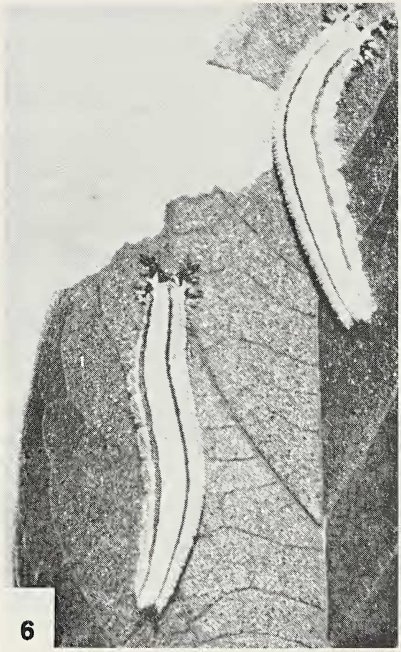
Description of the Immature Stages of *A. idyja argus*

Egg (Fig. 33). Egg whitish, typical of *Asterocampa*, 19 or 20 ribs, 0.80 mm wide by 0.85 mm high, deposited in large clusters. Micropylar rosette similar in design to that of *Apatura iris* (L.) (Friedrich, 1977), 6-8 petals; fovea centralis roughly triangular, micropylar openings at corners (occluded in figure).

Mature Larva (Figs. 1, 2, 6, 7, 9-13, 16-32). Fifth instar larva 3-4 cm long, male larvae 80% as long as females; body widest at middle, roughly 5 mm. Head 5 mm wide counting lateral scoli. Anal horns arising from dorsal plate, each 1 mm long.

Head (Figs. 1, 2, 10-13) mostly black, hairy, with whitish (yellowish white) patches on lower face and antlers posteriorly. Head capsule blackish with translucent areas through which tissues in living specimens appear whitish. Antler trunk, AB4, dark brownish black; AL concolorous anteriorly and at tip, but whitish posteriorly; AM dark only anteriorly on apical half. All other antler scoli whitish with dark brownish black tips, as are L1, 02 and V1. Other head scoli whitish, except in subocular region (SO1, SO3, brownish black). Whitish streaks mesad of ocular creases, ventrally to and including antennae. Frons whitish laterally on lower half, clypeus dark only at sides. Two pairs of whitish markings on occiput dorsally in lines extending back from antlers and back below each V3 scolus. Head appendages whitish to amber-colored (orange yellow), except black mandibles, brownish black basal portions of maxillae and labium, brown spinneret. Lower 3 simple eyes of arc-forming 4, ringed with black.

Body longitudinally striped with shades of yellow and green (olive), spiracles whitish. Anal horns black. Heart-line dark, olive black, centered dorsally, showing through unpigmented cuticle of body. Subdorsal bands broad, pale to light yellow, longitudinally bisected by intermittent medium olive line; outer (more lateral) portion of subdorsal band called dorsolateral band. Subdorsolateral bands olive black each with line of contrasting white chalazae more or less centered within and along dark olive center. Light yellow supraspiracular bands lateral to subdorsolateral bands. Spiracular bands olive with contrastingly light-colored spiracles



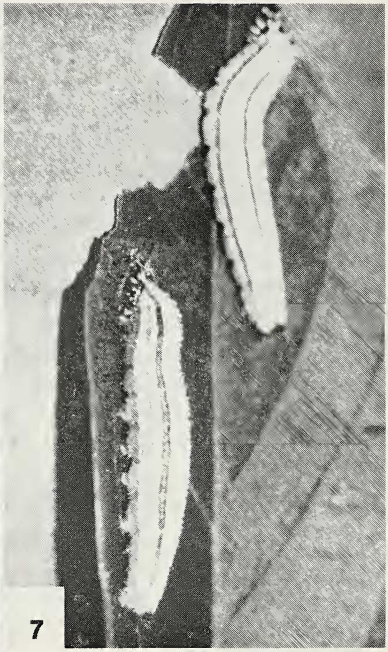
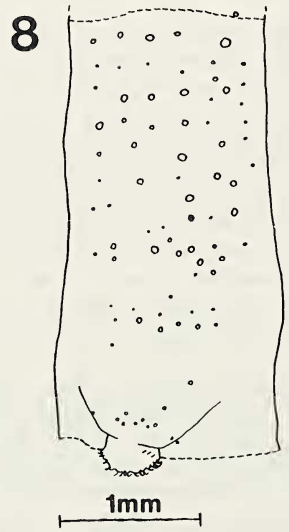


Fig. 6. Larva: Fifth instar, dorsal view.
Fig. 7. Larva: Fifth instar, lateral view.



Figs. 8 & 9. Lateral views of right, fifth abdominal, segment of larvae: **8,** third instar; **9,** fifth instar.

centered within and along deep yellow center. Subspiracular bands light yellow. Below subspiracular bands, including prolegs, thoracic legs and venter, olive. In some specimens, yellow bands more intense (strong yellow). Green color leached from larvae in alcohol, pinkish hue (light yellowish pink) of muscles showing through cuticle. Yellowish pigment a particulate substance remaining where deposited under cuticle (uric acid?) and filling bases of chalazae. Light-colored developing wing buds (laterally under cuticle of meso- and metathorax) and testes (males, on either side of heart-line under cuticle, abdominal segment 5) visible in wet-preserved specimens.

Cranial sclerites joined along pitted suture lines. Median facial sclerite reaching only middle of face dorsally. Vertex bulging dorsally, lateral cranial hemispheres closely and broadly appressed above epicranial suture hidden between. Face coarsely, evenly pitted dorsally at sides of epicranial suture, pits up to vertex, over to occiput. Another field of pits from bases of antlers, broadening towards simple eyes, surrounding large lateral scoli, but distant from adfrontal sutures. Pits reflect sites of mandibular muscle fiber attachment, fibers not extending inside head scoli or antlers. Head appendages (antennae, mouth parts) illustrated (Figs. 16-25).

Body integument shagreened, studded with white chalazae with colorless setae. Chalazae scattered over membranous cuticle, forming clumps defined by musculature, body segments and annuli. Membranous cuticle of body finely spiculiferous. Setae borne on chalazae above spiracular band generally short and blunt, those below acute and longer. Fused chalazae form plates at either side of pronotum anterodorsal to spiracles, rarely fused elsewhere.

Prothorax with 2 abutting dorsal plates studded with short, blunt setae borne on chalazae. Ventral prothoracic gland opening in broad, transverse slit anteromesad of prothoracic legs, internally a bilobed membranous sac with lobes each less than 1 mm long. Meso- and metathorax with 4 annuli each. Thoracic legs (Figs. 26, 27) smoothly sclerotized, covered with long setae, claws appendiculate.

Spiracles covered by sieve plates (Srivastava, 1975) composed of ciliated extensions of rim, posterior ones external, overlapping tips of those attached anteriorly.

Abdominal segments 1 and 2 with 4 annuli; segments 3-7 with 5 annuli; segment 8 with 3 annuli. Ninth abdominal segment narrow, bordering anal plate (Figs. 28, 29) dorsally. Plate beaded between chalazae as in pronotum. Prolegs (Figs. 30-32) with 3-ranked mesoseries of amber-colored (orange yellow) crochets, 90 per proleg, each striated longitudinally. Field of tiny, sclerotized hooks, named here **crampets** (meaning "tiny hooks," in the sense of "crampons," the climbing hooks of mountaineers), on mesal surface of proleg planta. Crampets individually "T"-shaped or spade-shaped, curving in same direction as crochets, probably for clasping silk. As the crampets occur mesally on the prolegs their action is probably more like Velcro^{R} than like the adhesion surfaces of the feet of house flies.

Third and Fourth Instar Larvae (Figs. 8, 14, 15). Larvae of these instars do not differ in any major way from mature larvae except in size. Some characters are compared in Table 1.

Head capsules of third and fourth instar larvae (Figs. 14, 15) maintain their integrity after being shed. Those of the fifth instar separate along the epicranial and adfrontal sutures. The pattern of light markings on the head differs slightly in

these instars. There is more white on the face and occiput dorsally in earlier instars than on the black head of the fifth instar. The antlers of the third instar are uniformly brownish black. Third instar larvae are lighter shades of green (olive) and yellow on the body, except for the heart-line; fourth instar larvae look like fifth instars in color. Third and fourth instar larvae have proportionally fewer chalazae and setae than fifth instar larvae.

Table 1. Comparison of larval characters among late instar *Asterocampa idyja argus* larvae.

Character (millimeters)	**Instar 3**	**Instar 4**	**Instar 5**
Body length (maximum)	13	*	30-40
Body width (maximum)	2	*	5
Head width (excluding scoli)	1.5	2.67	4.0
Antler length	0.15	1.2	1.9
Prothoracic spiracle height	0.16	0.44	1.0
Crochets/proleg (number)	30	40	90

*No data on maximum

Pupa (Figs. 34-36). Pupa typical of *Asterocampa*, 2.1-2.6 cm long, 0.7-0.9 cm wide, 0.9-1.2 cm high at abdominal crest maximum (third abdominal segment), females larger than males. Head prolongations blunt, carinate dorsally. Antennae, bases of legs and galeae rugose externally, antennal segments corresponding to successive pairs of bumps. Pupal case splits dorsally along median carina from head, just behind antennae to posterior edge of mesonotum. Metanotum very narrow medially (longitudinally). Anterior median edges of third through eighth abdominal segment produced into spines. Prothoracic spiracles opening into transverse slits just above antennae. Wings completely covering first abdominal segment spiracles; hind wings partially covering spiracles, abdominal segments 2 and 3; eighth abdominal spiracles vestigial in appearance. Cremaster with long pad packed with hooked spines spines between carinae sustentorum; pad "Y"-shaped (Fig. 36), as in *Chitoria* (Muroya et al., 1967), another apaturine genus. Pupa leaf green (yellowish green) with whitish markings and very cryptic. Dorsal carinae of head prolongations, median dorsal carina from pronotum to third abdominal segment, lateral carinae along protruding edges of hind wings, major veins of fore wings, marked with whitish. Diagonal white stripes on sides of abdominal segments 2-7 between crest and spiracles, higher ends of stripes posterior; no subspiracular longitudinal stripes. Black spots on either side of spines on abdominal segments 3-8.

Discussion

Asterocampa idyja remains the least known species of hackberry butterfly. Biologically and morphologically the immature stages place the species in the Clyton Group of Skinner (1911), from which they can be separated from *A. clyton* geographically and morphologically. The black head and anal horns of the late instar larvae, as noted by Gundlach (1881), and the short metanotum of the pupa are diagnostic for *A. idyja*. The larval body is striped like some eastern larval populations of *A.*

clyton, but tending to more intense shades of yellow and green (olive). N. D. Riley's (1975) abbreviated description of the mature larva, presumably based on Gundlach's article, is in error in stating that the larvae have orange (instead of yellow, "amarilla" in Gundlach) longitudinal body stripes. It is hoped that *A. idyja idyja* will soon be described in sufficient detail for comparison with *A. idyja argus*, described here.

A population of *A. idyja argus* has recently been discovered in Sonora, Mexico, by collectors from Arizona. There is virtually no difference in morphology between this population and others in Mexico.

There is much work to be done on the biology of *A. idyja argus*. Different host plants should be encountered in the peripheral parts of the butterfly's range. In northwestern Mexico, the immature stages have been found on *Celtis reticulata* Torr., and in northeastern Mexico, one would expect them to be on *C. laevigata* Willd. In Guatemala, Honduras and Nicaragua the host tree is probably *C. trinervia* Lam., just as it is in the Greater Antilles for this species.

Interested field lepidopterists should search for gravid females and unhatched egg masses to get fresh eggs and early instar larvae for study. One would expect a variety of parasites and predators to be found associated with all the developmental stages of *A. idyja argus*, once the butterfly is better known.

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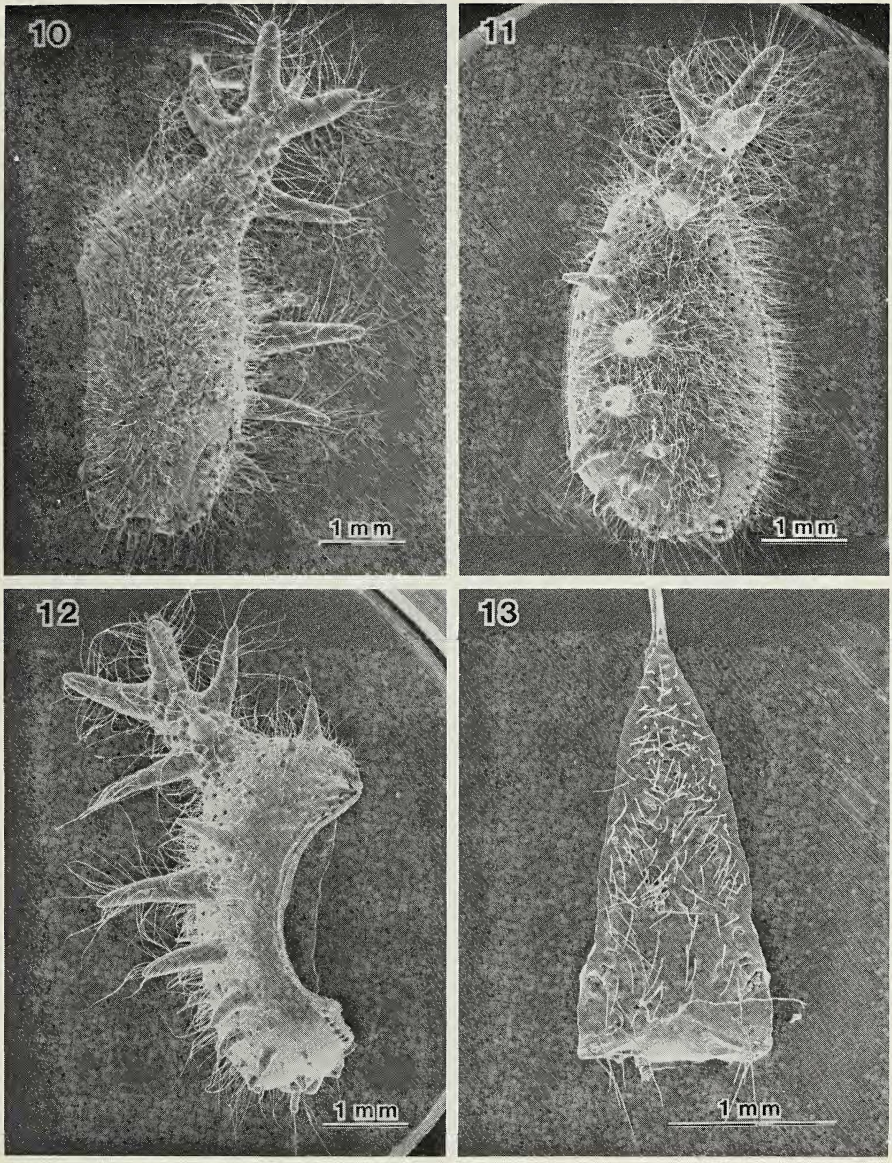
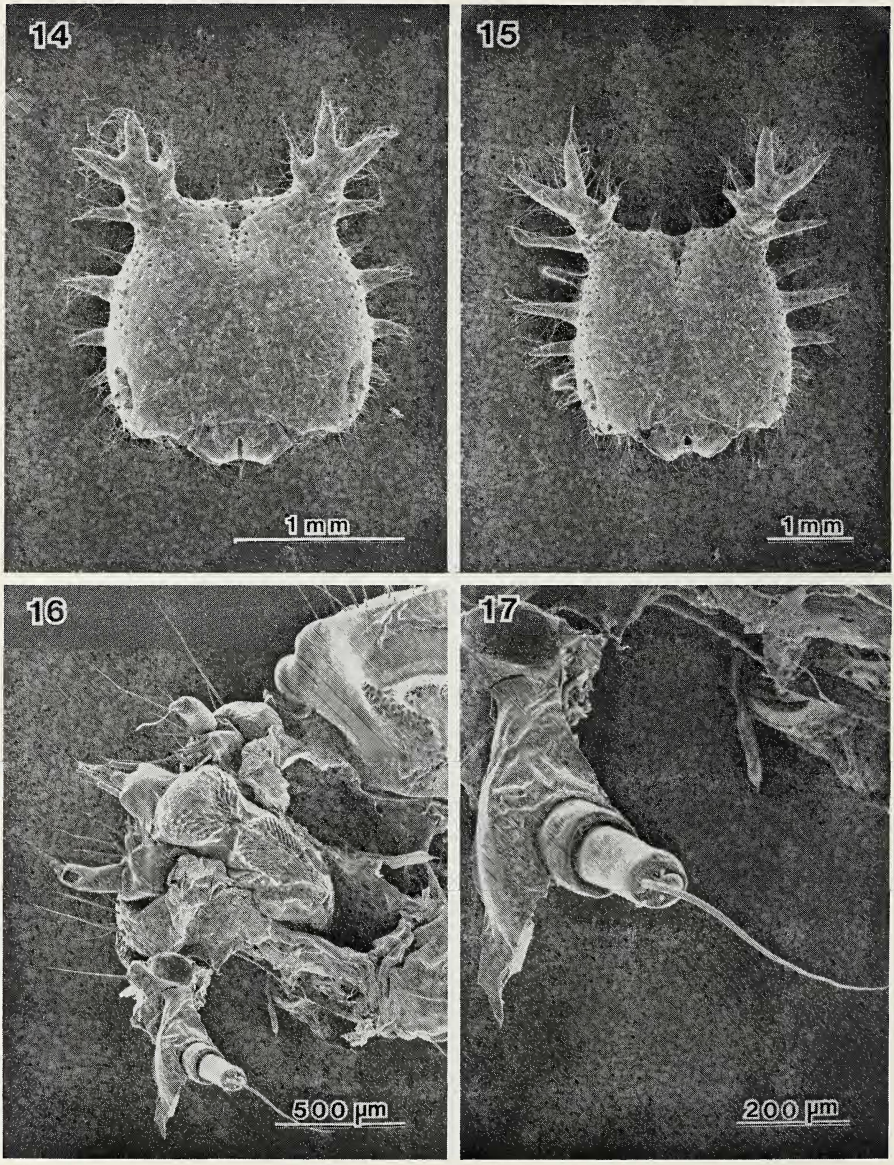
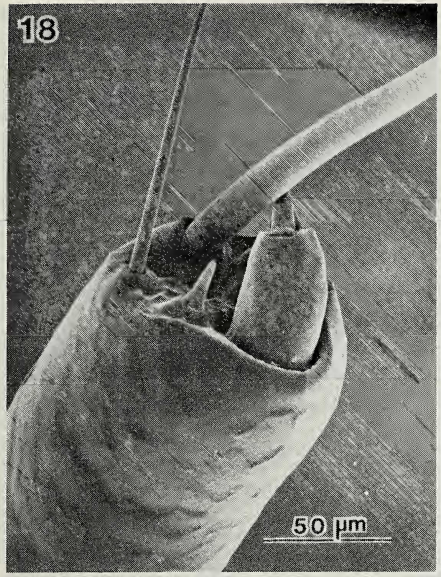


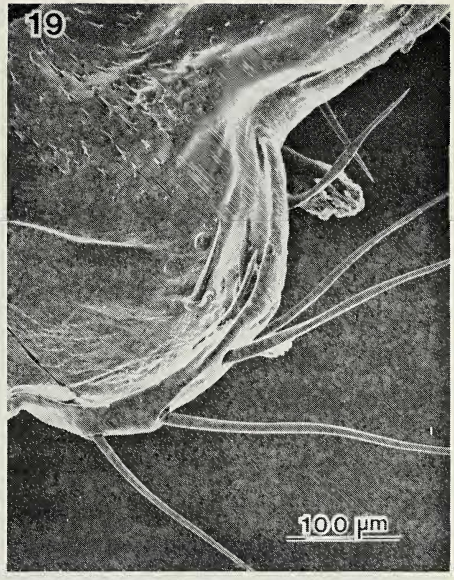
Figs. 10-13. Head capsule of mature larva: **10,** left front; **11,** right side; **12,** left back; **13,** median facial sclerite, as shed (with labrum removed).

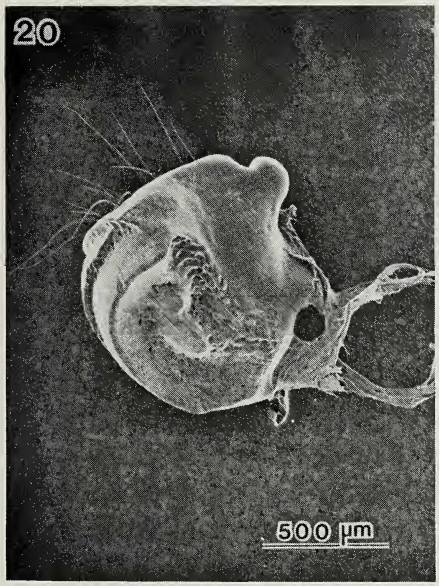


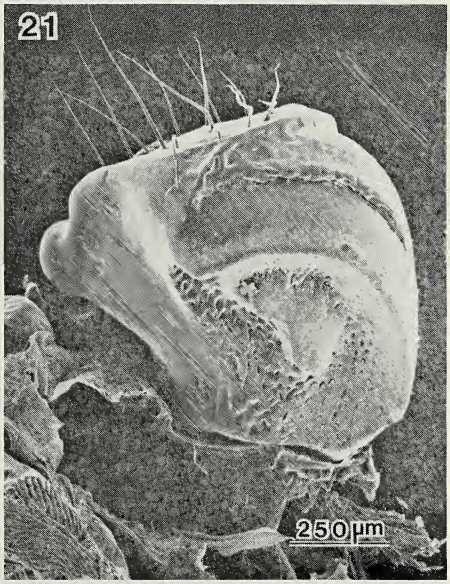
Figs. 14 & 15. Head capsules of larva: **14,** third instar; **15,** fourth instar.

Figs. 16 & 17. Head appendages of mature larva (left mandible, right antenna, not shown): **16,** front view (ventral to the left); **17,** left antenna (slightly collapsed at tip).



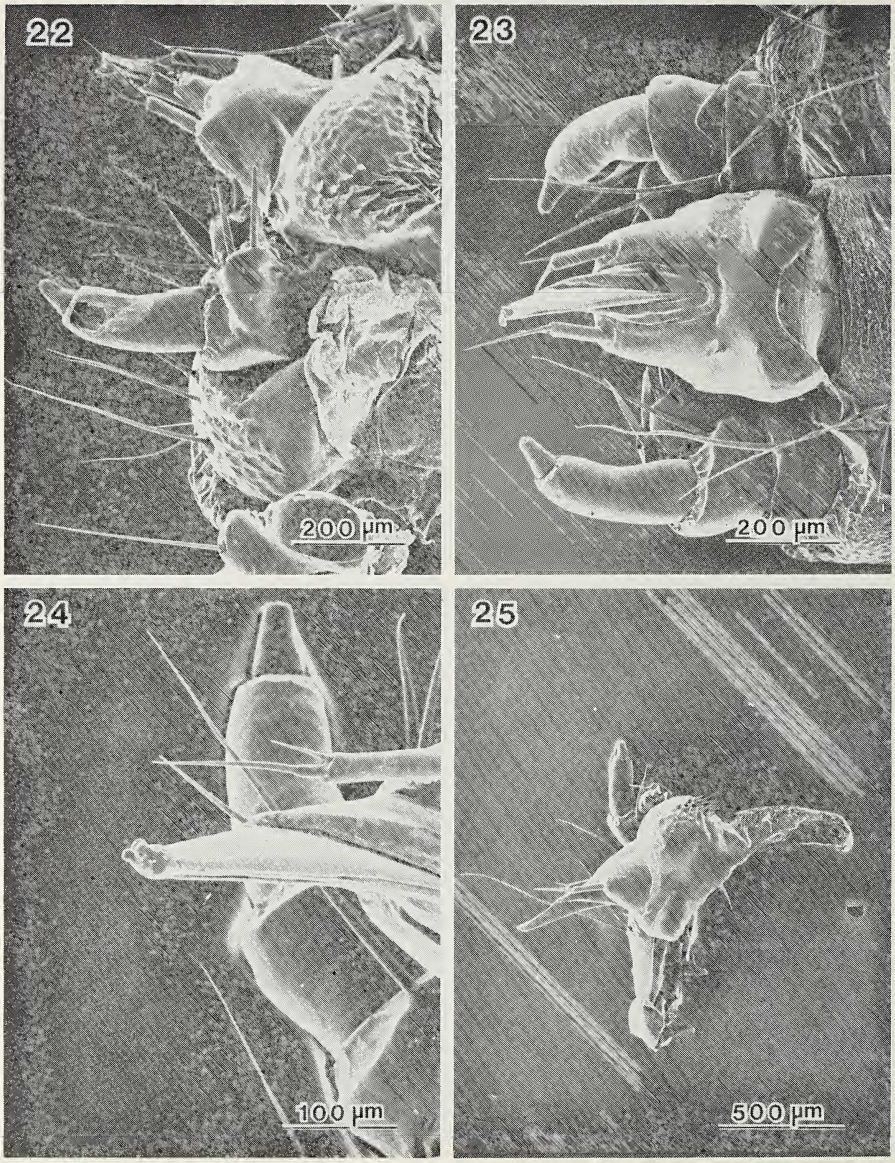




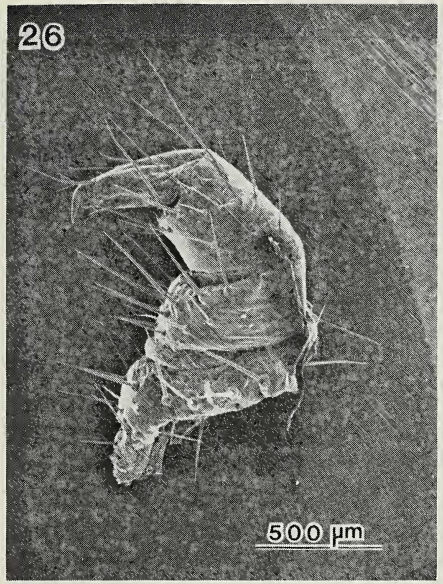


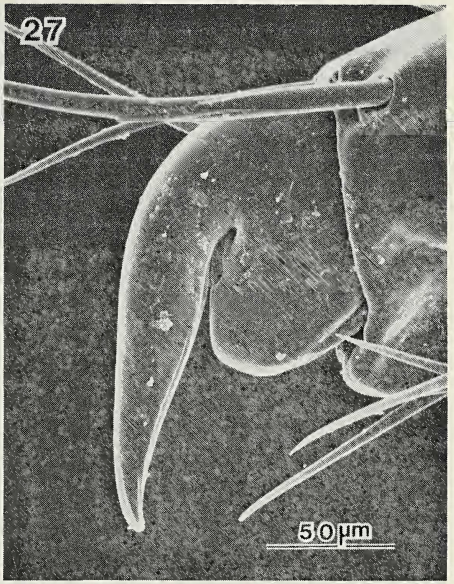
Figs. 18 & 19. Head appendages of mature larva (left mandible, right antenna, not shown): **18,** left antenna (slightly collapsed at tip); **19,** underside of labrum (note: minute cilia (found laterally), adoral spines, pores and setae).

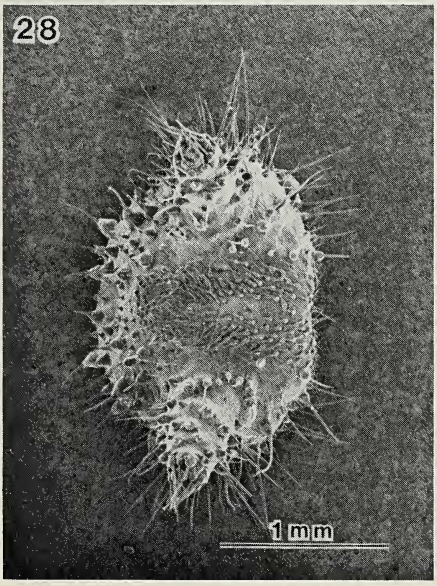
Figs. 20 & 21. Mandibles of mature larvae: **20,** left; **21,** right.

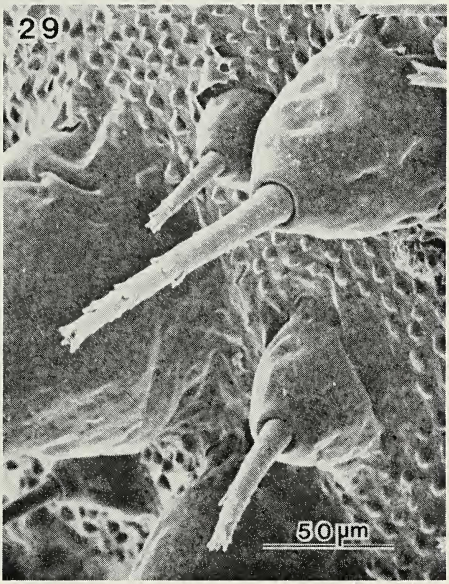


Figs. 22-25. Maxillae, hypopharyngeal complex of mature larvae: **22,** anterior view (ventral to the left); **23,** posterior view; **24,** spinneret (note: terminal nobs); **25,** lateral view of hypopharyngeal complex (left maxilla removed).



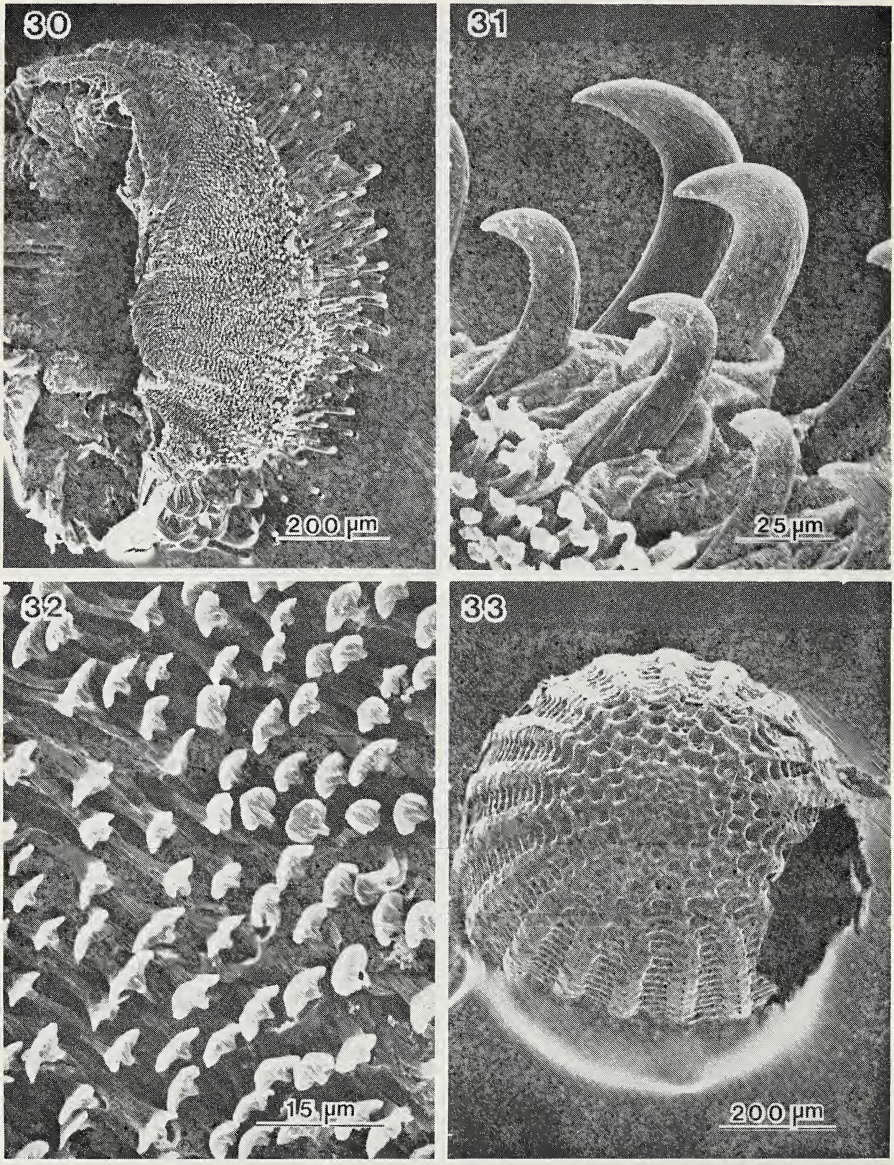






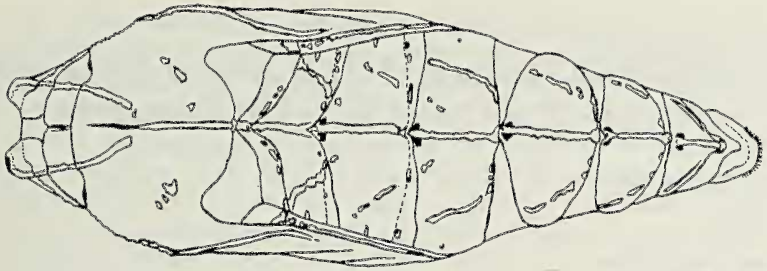
Figs. 26 & 27. Thoracic leg of mature larva: **26,** anterior view; **27,** claw.

Figs. 28 & 29. Anal plate of mature larva: **28,** posterior view (ventral to the right); **29,** dorsal chalazae (note: short-branched nature of setae, beaded texture of cuticle between chalazae).



Figs. 30-32. Fourth, right abdominal proleg of mature larva: **30,** mesal surface; **31,** crochets; **32, crampets.**

Fig. 33. Egg: Dorsal view (note: exit hole made by scelionid parasitoid).



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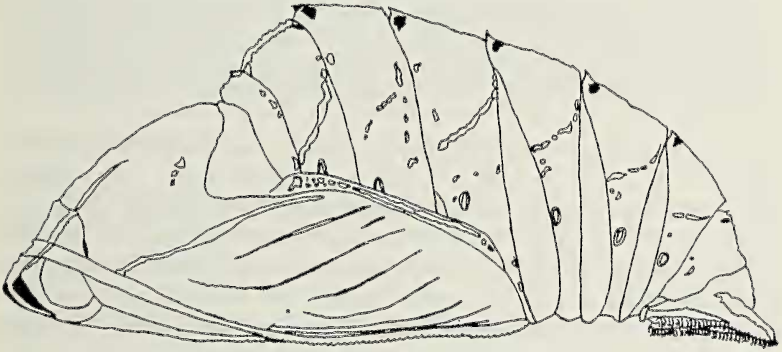
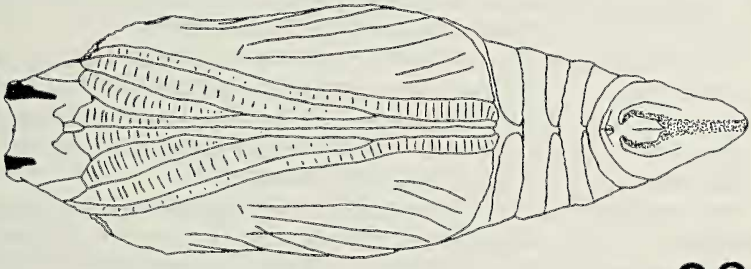


35



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Figs. 34-36. Pupa: **34,** dorsal view; **35,** lateral view; **36,** ventral view.